## CLAIMS

1. An electric submersible pump containing an AC permanent magnet motor having three or more phases (A, B, C) and drive means (902, 903) for supplying drive signals to all the phases of the motor at the same time, each drive signal being constituted by a cyclically smoothly varying voltage applied to the corresponding motor phase during driving of the motor.

2. A pump according to claim 1, wherein the drive means (902, 903) is adapted to apply a non-sinusoidally varying voltage to each motor phase.

3. A pump according to claim 1 or 2, wherein the drive means comprises switching means (902, 903) for each motor phase, control means for turning the switching means (902, 903) on and off at a frequency greater than the frequency of the cyclically smoothly varying voltages, and filter means (907, 908) for filtering the output voltages of the switching means (902, 903) to produce the cyclically smoothly varying voltages.

4. A drive circuit for an electric submersible pump, comprising means (113, 902, 903) for generating cyclically varying waveforms in which the voltage varies substantially smoothly during each transition between an upper voltage level and a lower voltage level and in which the voltage remains at substantially the upper voltage level for first predetermined periods between successive transitions and the voltage remains at substantially the lower voltage level for second predetermined periods between successive transitions interleaved with said first periods, and output means (901) for applying said waveforms to energise a plurality of phases (A, B, C) of a motor driving the electric submersible pump.

5. A drive circuit according to claim 4, wherein the generating means (113, 902, 903) is adapted to drive all of the phases (A, B, C) of the motor simultaneously to prevent the generation of voltage spikes in the motor.

6. A drive circuit according to claim 4 or 5, wherein the generating means comprises a variable voltage source (113) for supplying the difference between the

upper voltage level and the lower voltage level, and switching means (902, 903) for alternately applying the voltages at the upper and lower voltage levels supplied by the variable supply voltage source (113).

7. A drive circuit according to claim 6, wherein the switching means (902, 903) is adapted to vary the time-dependent sequence with which the upper and lower voltage levels are applied in order to provide the substantially smooth transitions between the upper and lower voltage levels.

8. A drive circuit according to claim 7, wherein the switching means (902, 903) is adapted to vary the time-dependent sequence with which the upper and lower voltage levels are applied to the output means in order to provide pulse width modulated output voltages at the transitions.

9. A drive circuit according to claim 6, 7 or 8, wherein the switching means (902, 903) is adapted to apply the voltages at the upper and lower voltage levels to filter means (907, 908) for applying said waveforms to energise the phases (A, B, C) of the motor by way of the output means (901).

10. A drive circuit according to any one of claims 6 to 9, wherein the variable voltage source (113) is adapted to control the speed of the motor at higher speeds.

11. A drive circuit according to any one of claims 6 to 10, wherein the variable voltage source (113) is adapted to non-linearly modulate the switching means (902, 903) so as to provide waveforms having portions in which the voltage is maintained at substantially the upper and lower voltage levels for extended periods of time.

12. A drive circuit according to any one of claims 6 to 11, wherein the variable voltage source (113) is adapted to vary its internal frequency with output so as to improve efficiency.

13. A drive circuit according to any one of claims 6 to 12, wherein the variable voltage source (113) comprises chopper means (1401-6) for chopping a fixed voltage in

a variable time–dependent sequence in order to supply the voltages at the upper and lower voltage levels.

14. A drive circuit according to claim 13, wherein the chopper means comprises capacitance means (1406) connected to first and second fixed supply voltage sources (1401, 1402), and selection means (1403) for selectively applying the voltage (1407, 1408 defined by the first and second fixed supply voltage sources (1401, 1402).

15. A drive circuit according to claim 14, wherein the chopper means is adapted to vary the duty cycle of the selection means (1403) to adjust the voltage across the capacitance means (1406)

16. A drive circuit according to any one of claims 6 to 12, wherein the variable voltage source (113) comprises a poly-phase boost converter adapted to supply the difference between the upper voltage level and the lower voltage level from a poly-phase supply.

17. A drive circuit according to any one of claims 4 to 16, wherein the generating means comprises transformer means having a first secondary winding constituting a first fixed supply voltage source and a second secondary winding constituting a second fixed supply voltage source.

18. A drive circuit for controlling driving of a synchronous motor comprising means for varying the drive current or voltage supplied by the circuit to drive the motor while the motor is driven at a fixed speed, means for monitoring the output power of the circuit during such variation of the drive current or voltage in order to determine the minimum output power required to drive the motor at said fixed speed, and means for controlling the output power of the circuit in order to minimise the output power of the circuit required to drive the motor at said fixed speed.

19. A drive circuit for controlling driving of a permanent magnet motor comprising means for varying, relative to an estimated rotor position of the motor, the phase of the drive current or voltage supplied by the circuit to drive the motor while said current or

voltage is held at a fixed amplitude, means for monitoring the motor speed during such variation of the drive current or voltage in order to determine the maximum speed at which the motor can be driven by the available output power, and means for controlling the phase of the drive current or voltage in order to maximise the motor speed.

20. A method of driving a permanent magnet motor, comprising the steps of varying the magnitude and/or phase of the drive current or voltage supplied by a drive circuit to drive the motor while the motor is driven at a fixed speed, monitoring the output power of the circuit during such variation of the magnitude and/or phase of the drive current or voltage in order to determine the minimum output power required to drive the motor at said fixed speed, and controlling the output power of the circuit in order to minimise the output power of the circuit required to drive the motor at said fixed speed.

21. A method of driving a permanent magnet motor, comprising the steps of varying, relative to an estimated rotor position of the motor, the phase of the drive current or voltage supplied by the circuit to drive the motor while said current or voltage is held at a fixed amplitude, monitoring the motor speed during such variation of the drive current or voltage in order to determine the maximum speed at which the motor can be driven by the available output power, and controlling the phase of the drive current or voltage in order to maximise the motor speed.

22. A method according to claim 20 or 21 for driving an electric submersible pump connected to the motor by cable means, whereby changes in the resistance and reactance and/or the operating temperature and/or the age of the motor and the cable means are compensated for.

23. A downhole permanent magnet motor having a rotor (201, 203, 204, 205) bearing permanent magnets (204), and a stator (202, 206) arranged coaxially with respect to the rotor such that an annular gap (209) is provided between the rotor and the stator for lubricating fluid, wherein the size of the gap (209) is such that the fluid flow is turbulent during rotation of the rotor above a critical rotation speed below which turbulent flow is physically impossible.

24. A motor according to claim 23, wherein the size of the gap (209) is such that the likelihood of incurring mechanical damage whilst in use is substantially reduced.

25. A motor according to claim 23 or 24, wherein the gap (209) is greater than 1.25 mm.

26. A downhole motor having a stator and an elongate rotor supported by a bearing (401) with respect to the stator, wherein the bearing is provided with spiral grooving (409) for supplying lubricating fluid to the bearing (401) in such a manner as to impart stability to the bearing (401).

27. A motor according to claim 26, wherein the arrangement is such that fluid is circulated through the motor separately from lubrication of the bearing.

28. A motor according to claim 26 or 27, wherein the stator has a bore that is grooved in the vicinity of the bearing to promote free flow of fluid therethrough.

29. A motor according to claim 26, 27 or 28, wherein the rotor is mounted on a shaft, and a passage is provided through the shaft for the supply of fluid to the bearing.